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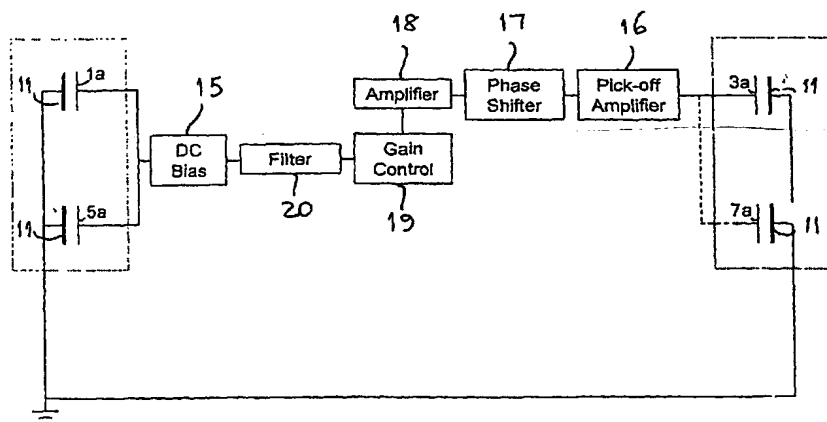
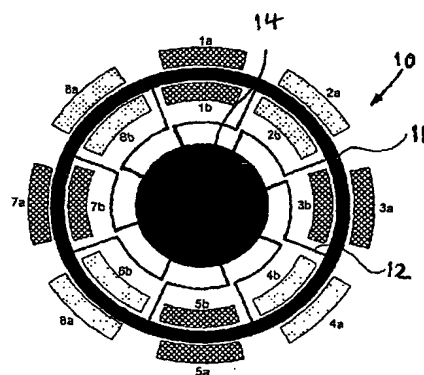
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[Continued on next page]

(54) Title: MICRO-ELECTROMECHANICAL SYSTEMS



(57) Abstract: A micro-electro-mechanical system (MEMS) comprises a substrate incorporating an oscillatory ring (11), forcing electrodes (1a, 1b, 5a, 5b) for driving the ring into resonance, and sensing electrodes (3a, 3b, 7a, 7b) providing an electrical output signal dependent on oscillation of the ring as a result of such forcing and any externally applied force. A positive feedback circuit is provided for feeding back a signal dependent on the output signal of the sensing electrodes (3a, 3b, 7a, 7b) to the forcing electrodes (1a, 1b, 5a, 5b) in order to sustain oscillation of the ring. The use of positive feedback to drive the forcing electrodes in order to sustain oscillation of the ring is highly advantageous in such an application since it produces a system which exhibits very low phase noise of a magnitude considerably less than the phase noise experienced in use of a phase-lock loop circuit to sustain oscillation.

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# INTERNATIONAL SEARCH REPORT

International Application No

PC/EP 0073

## A. CLASSIFICATION OF SUBJECT MATTER

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According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G01C B81B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal, INSPEC, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 152 216 A (MURATA MANUFACTURING CO) 7 November 2001 (2001-11-07) the whole document	1-17, 21-24
A	AYAZI F ET AL: "A HARPSS POLYSILICON VIBRATING RING GYROSCOPE" JOURNAL OF MICROELECTROMECHANICAL SYSTEMS, IEEE INC. NEW YORK, US, vol. 10, no. 2, June 2001 (2001-06), pages 169-179, XP001123587 ISSN: 1057-7157 the whole document	1-17, 21-24
X	US 5 587 529 A (IGUCHI YUTAKA ET AL) 24 December 1996 (1996-12-24) column 11, line 4 - line 28; figure 8	1

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

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# INTERNATIONAL SEARCH REPORT

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 561 400 A (IGUCHI YUTAKA ET AL) 1 October 1996 (1996-10-01) column 6, lines 17-29; figures 2,,3B -----	1
X	SANGKYUNG SUNG ET AL: "Development of a tunable resonant accelerometer with self-sustained oscillation loop" PROCEEDINGS OF THE IEEE 2000 NATIONAL AEROSPACE AND ELECTRONICS CONFERENCE. NAECON 2000. ENGINEERING TOMORROW (CAT. NO.00CH37093), DAYTON , 2000, PISCATAWAY, NJ, USA, IEEE, USA, PAGE(S) 354 - 361 , XP001156567 ISBN: 0-7803-6262-4 figures 2-4 -----	1
X	BURRER C ET AL: "High-precision BESOI-based resonant accelerometer" SENSORS AND ACTUATORS A, ELSEVIER SEQUOIA S.A., LAUSANNE, CH, vol. 50, no. 1-2, August 1995 (1995-08), pages 7-12, XP004303507 ISSN: 0924-4247 page 9, right-hand column; figure 4 -----	1
X	US 5 731 519 A (OGAWA KENJI) 24 March 1998 (1998-03-24) figures 1-27 -----	1
X	US 5 672 949 A (WARD PAUL) 30 September 1997 (1997-09-30) figures 1-16 -----	1

# INTERNATIONAL SEARCH REPORT

International Application No.  
PCT/03/50073

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-17, 21-24

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-17,21-24

A MEMS with a positive feedback circuit

2. Claims: 18-24

A MEMS with two or more forcers

The application does not relate to one single group of inventions linked by a single general inventive concept as required by Article 3(4)iii) PCT and Rule 13 PCT.

The first inventions (claims 1-17 and 21-24 (insofar as they depend on claims 1-17)) concerns a resonant MEMS sensor. The resonance must be sustained by circuitry. This is achieved using a feedback loop.

The second invention (claims 18-20 and 21-24 (insofar as they depend on claims 18-20)) concerns a resonant MEMS sensor as well. Furthermore more than two "forcers" are provided distributed at certain angular intervals.

Claim 1 (of the first invention) defines "forcing means". It is clear that for driving the sensor there must be at least one forcer. Claim 1 does not define (explicitly or implicitly) two or more forcers.

Claim 18 (of the second invention) does not define any circuitry at all, and in particular no feedback circuitry.

The problem to be solved by the first invention according to the description of the present application is to produce a system exhibiting very low phase noise (cf. page 3, line 2 from the bottom - page 4, line 10). The solution is to provide "positive feedback".

The problem to be solved by the second invention according to the description of the present application is to enable a sub-set of the various resonant modes of the resonator to be stimulated (cf. page 5, 2. and 3. paragraphs). The solution is to provide two or more "forcers".

Hence the first and the second inventions address different problems and provide different solutions.

The prior-art document "Development of a tunable resonant accelerometer with self-sustained oscillation loop" by Sangkyung Sung et al., Proceedings of the IEEE 2000 National Aerospace and Electronics Conference, NAECON 2000, Engineering Tomorrow, Dayton, OH, USA, 10-12 Oct. 2000, Piscataway, NJ, USA, IEEE, USA (ISBN 0-7803-6262-4), pages 354 - 361 is called D1 in the following. D1 discloses a micro-electromechanical system (MEMS) comprising a substrate incorporating an oscillatory member, forcing means for driving the oscillatory member into resonance, and electrical sensing means providing an electrical output signal dependent on oscillation of the oscillatory member as a result of such forcing and any externally

applied force (cf. D1, Figs. 2-4 and description thereof).

These features are the common concept linking claims 1 and 18. Hence claims 1 and 18 have no special technical feature in common as required by Rule 13.2 PCT.

It is noted, that it appears that D1 also disclose the remaining features of claim 1, i.e. that a positive feedback circuit is provided for feeding back a signal dependent on the output signal of the sensing means to the forcing means in order to sustain oscillation of the oscillatory member (cf. D1, Fig. 4 and description thereof). It would therefore appear that claim 1 of the present application is not new in the sense of Article 33(2) PCT. It is hence not possible to identify a problem solved by the MEMS device as defined in claim 1 when compared with the device disclosed in D1.

## INTERNATIONAL SEARCH REPORT

International Application No

PO EP 50073

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